General Physics

DETERMINATION OF VISCOSITY FROM THE DISPERSION RELATION OF CAPILLARY WAVES

Justin A. Smith, Wes P. Even, and F. Behroozi*

Department of Physics
University of Northern Iowa
Cedar Falls, IA 50614
E-mail: jsmith@uni.edu
weseven@uni.edu
fred.behroozi@uni.edu

Abstract

Surface tension and viscosity determine the propagation and attenuation of capillary waves on fluids. We have developed a miniature laser interferometer to map the profile of the capillary waves with a precision of ±10 nanometers. This system enables us to obtain the dispersion and attenuation of capillary waves with great precision.

To obtain the dispersion relation, we first establish a standing capillary wave on the surface. The interferometer is then employed to determine the distance between successive nodes from which the wavelength is obtained to within a micrometer. Fluid viscosity alters the dispersion relation for capillary surface waves at high frequencies. Therefore, experimental data on dispersion provides a novel means to determine the viscosity of the fluid.

We have explored the effect of viscosity on the dispersion relation of capillary waves in the glycerin-water system. Our latest results indicate that, at higher frequencies, viscosity indeed alters the dispersion relation of capillary waves to such an extent that a determination of viscosity from the dispersion data is possible. We present dispersion data for a 60% glycerin-water solution and discuss how the data may be used to extract the viscosity of the mixture. Furthermore the dispersion data is used to obtain very accurate values of the surface tension.